With the present prices of CD burners and CD-R discs, making your own audio CDs with your own choice of music is an attractive possibility. You can for example make a compilation of tunes from existing CDs, or you can copy your favourite tracks from LPs onto a CD. In the latter case, the sound quality can be improved in numerous ways with the help of special software. In this article, we provide some general guidelines and technical details for those of you that want to start making your own audio CDs.

make your own music CDs

Digitizing LPs and making your own compilations

Although nowadays everybody in the computer world is talking about MP3 audio, the normal audio CD is still the most important recording medium for the true audio fan, as far as quality is concerned. The data on an audio CD are not compressed and are recorded at a sampling rate of 44.1 kHz with 16-bit resolution.

To put together an audio CD, you can use a special audio CD recorder, such as the one made by Philips. However, the features of such a recorder are rather limited. If you want to edit or clean up the audio files, you will have to resort to a computer with a CD burner.

Currently, one of the CD-recording programs Easy CD Creator (from Adaptec) or Win On CD (from Cequadrat) is most often supplied with the CD burner. We can use a few screen shots from the latter program to illustrate what you have to pay attention to when making an audio CD.

Copying CDs

The easiest task is simply making a 1:1 copy of an audio CD.

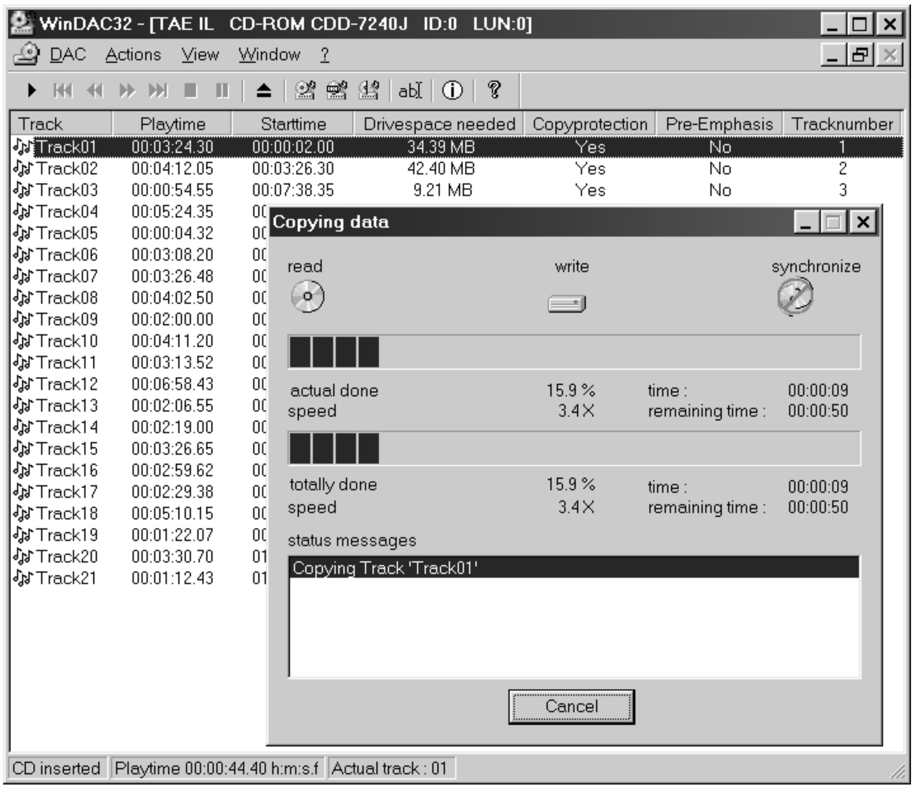
Before you start copying a CD, the CD reader must first be tested. This is because the error correction for audio CDs is much less extensive than for CD-ROMs. As a result, modern 32 or 40-speed CD drives can typically read audio CDs at a maximum speed of 4 or 8 times the normal rate. Most CD recording programs have a test option to determine the maximum rate at which the drive can read the audio data without errors. Note however that the reliability of the test results can vary, depending on the testing method used. It can thus be better to use a separate 'ripper' program (as it's called in trade jargon), which is specially designed to read the data from an audio CD. Some examples of such programs are Digital Audio Copy (*www.windac.de*) and Easy CD-DA Extractor (*www.polkasoft.com/cddal*).

Win On CD also provides jitter correction for reading in audio data. With most modern CD drives, the quality of the read data is good enough that jitter correction is normally not necessary, but with older-model drives it can be essential for obtaining good results.

After you have determined the best data transfer rate from the CD-ROM drive, you can copy the desired tracks. With a 1:1 copy, you can either copy the tracks directly to the CD burner or you can first make an ‘image’ on the hard disk. An image is a replica of the content of the CD. It is usually written to the hard disk as a wav file, and then read out and converted to the normal audio CD format when the new CD is recorded. Keep in mind that you will need around 700 MB of free space on the hard disk for an image of an audio CD.

When putting together a compilation CD, you can first copy the individual tracks to the hard disk and then record the collected tracks on a CD in the desired sequence.

That’s basically it, but there are a few things that you have to watch out for.



Track	Playtime	Starttime	Drivespace needed	Copyprotection	Pre-Emphasis	Tracknumber
Track01	00:03:24.30	00:00:02.00	34.39 MB	Yes	No	1
Track02	00:04:12.05	00:03:26.30	42.40 MB	Yes	No	2
Track03	00:00:54.55	00:07:38.35	9.21 MB	Yes	No	3
Track04	00:05:24.35	00				
Track05	00:00:04.32	00				
Track06	00:03:08.20	00				
Track07	00:03:26.48	00				
Track08	00:04:02.50	00				
Track09	00:02:00.00	00				
Track10	00:04:11.20	00				
Track11	00:03:13.52	00				
Track12	00:06:58.43	00				
Track13	00:02:06.55	00				
Track14	00:02:19.00	00				
Track15	00:03:26.65	00				
Track16	00:02:59.62	00				
Track17	00:02:29.38	00				
Track18	00:05:10.15	00				
Track19	00:01:22.07	00				
Track20	00:03:30.70	01				
Track21	00:01:12.43	01				

Copying data

read
write
synchronize

actual done 15.9 % time : 00:00:09
speed 3.4X remaining time : 00:00:50

totally done 15.9 % time : 00:00:09
speed 3.4X remaining time : 00:00:50

status messages

Copying Track 'Track01'

Cancel

CD inserted | Playtime 00:00:44.40 h:m:s.f | Actual track : 01

Figure 1. A ‘ripper’, such as Digital Audio Copy, can be used to transfer exact 1:1 copies of CD audio tracks to the hard disk.

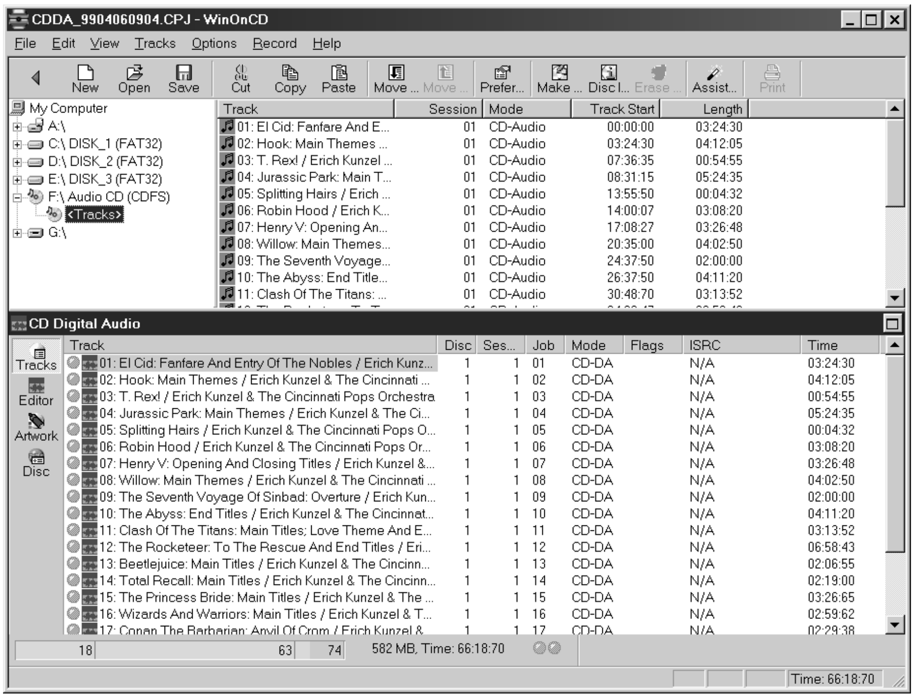
Track at once or disc at once?

Normally, in track-at-once mode, a 2-second gap is inserted between successive tracks by the CD burner. This is not exactly what normal audio CD players want to see. It can often completely disrupt their operation, since the laser beam is switched off while the gap is recorded.

When copying an entire CD, the CD burner often automatically transfers all the tracks and records them ‘chained together’. If you are recording a number of tracks that you have collected yourself, you must take care that the option ‘disc at once’ is selected in the CD burner program. In this case pauses will still be inserted between the individual tunes, but the laser beam will not be switched off between tracks.

Pre-emphasis

You may not be particulary familiar with this term. In the early days of audio CDs, a form of pre-emphasis was sometimes used to improve the dynamic range for high frequencies. With pre-emphasis, all frequencies above 3kHz are recorded a few dBs louder on the CD. This setting is detected by the CD player during playback, so that a de-emphasis filter can be switched in to restore the original levels. Nowadays this technique is totally unnecessary and is not used. However, if you are copying tracks from old CDs you have to check whether they were recorded with pre-emphasis. The burner software will normally not indicate this, but you can always check it by simply inserting the CD into a normal audio CD player, which usually will indicate whether pre-emphasis is present. Some CD copying programs, such as Digital Audio Copy, also indicate whether the pre-emphasis bit is set in the original recording.



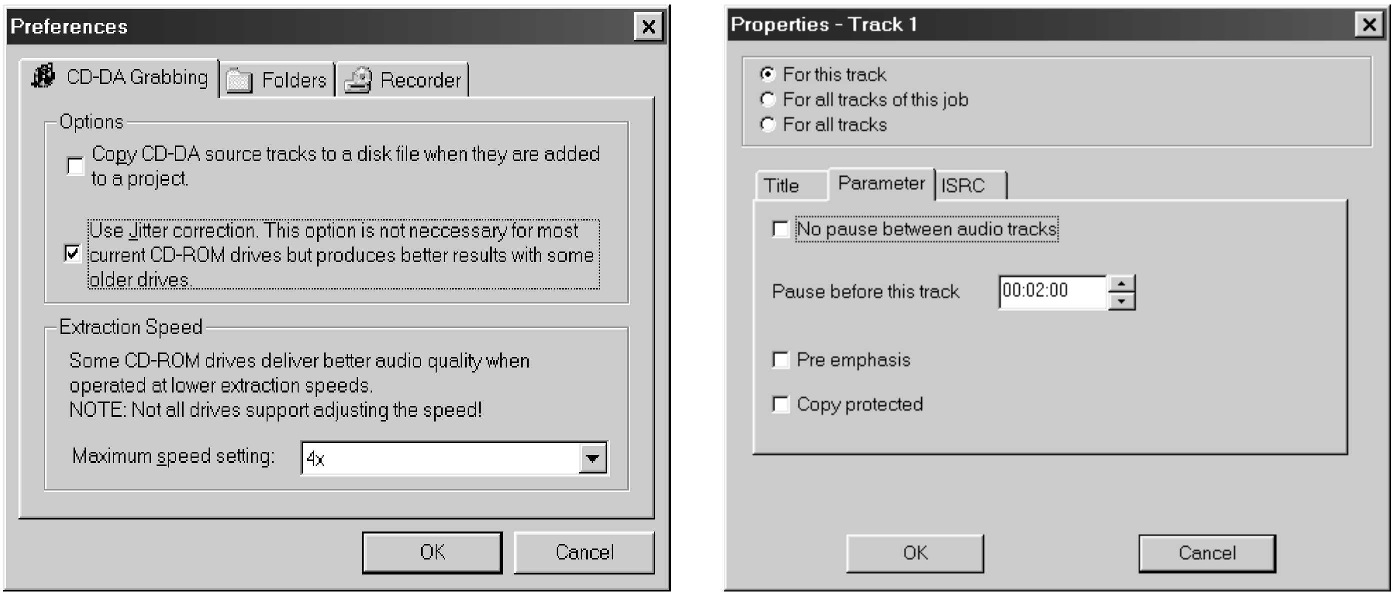
Track	Session	Mode	Track Start	Length
01: El Cid: Fanfare And E...	01	CD-Audio	00:00:00	03:24:30
02: Hook: Main Themes ...	01	CD-Audio	03:24:30	04:12:05
03: T. Rex! / Erich Kunzel ...	01	CD-Audio	07:36:35	00:54:55
04: Jurassic Park: Main T...	01	CD-Audio	08:31:15	05:24:35
05: Splitting Hairs / Erich ...	01	CD-Audio	13:55:50	00:04:32
06: Robin Hood / Erich K...	01	CD-Audio	14:00:07	03:08:20
07: Henry V: Opening An...	01	CD-Audio	17:08:27	03:26:48
08: Willow: Main Themes...	01	CD-Audio	20:35:00	04:02:50
09: The Seventh Voyage...	01	CD-Audio	24:37:50	02:00:00
10: The Abyss: End Title...	01	CD-Audio	26:37:50	04:11:20
11: Clash Of The Titans: ...	01	CD-Audio	30:48:70	03:13:52

Track	Disc	Ses...	Job	Mode	Flags	ISRC	Time
01: El Cid: Fanfare And Entry Of The Nobles / Erich Kunz...	1	1	01	CD-DA		N/A	03:24:30
02: Hook: Main Themes / Erich Kunzel & The Cincinnati ...	1	1	02	CD-DA		N/A	04:12:05
03: T. Rex! / Erich Kunzel & The Cincinnati Pops Orchestra	1	1	03	CD-DA		N/A	00:54:55
04: Jurassic Park: Main Themes / Erich Kunzel & The Ci...	1	1	04	CD-DA		N/A	05:24:35
05: Splitting Hairs / Erich Kunzel & The Cincinnati Pops O...	1	1	05	CD-DA		N/A	00:04:32
06: Robin Hood / Erich Kunzel & The Cincinnati Pops Or...	1	1	06	CD-DA		N/A	03:08:20
07: Henry V: Opening And Closing Titles / Erich Kunzel &...	1	1	07	CD-DA		N/A	03:26:48
08: Willow: Main Themes / Erich Kunzel & The Cincinnati ...	1	1	08	CD-DA		N/A	04:02:50
09: The Seventh Voyage Of Sinbad: Overture / Erich Kun...	1	1	09	CD-DA		N/A	02:00:00
10: The Abyss: End Titles / Erich Kunzel & The Cincinnat...	1	1	10	CD-DA		N/A	04:11:20
11: Clash Of The Titans: Main Titles; Love Theme And E...	1	1	11	CD-DA		N/A	03:13:52
12: The Rocketeer: To The Rescue And End Titles / Eri...	1	1	12	CD-DA		N/A	06:58:43
13: Beetlejuice: Main Titles / Erich Kunzel & The Cincinn...	1	1	13	CD-DA		N/A	02:06:55
14: Total Recall: Main Titles / Erich Kunzel & The Cincinn...	1	1	14	CD-DA		N/A	02:19:00
15: The Princess Bride: Main Titles / Erich Kunzel & The ...	1	1	15	CD-DA		N/A	03:26:65
16: Wizards And Warriors: Main Titles / Erich Kunzel & T...	1	1	16	CD-DA		N/A	02:59:62
17: Conan The Barbarian: Anvil Of Crom / Erich Kunzel &	1	1	17	CD-DA		N/A	02:29:38

18 | 63 | 74 | 582 MB, Time: 66:18:70

Time: 66:18:70

Figure 2. Most CD burning software is designed with two main windows, so that tracks can simply be dragged from the one window (the ‘explorer’ window) to the other window (the CD-R that is to be burned).



Options

☐ Copy CD-DA source tracks to a disk file when they are added to a project.

☑ Use Jitter correction. This option is not neccessary for most current CD-ROM drives but produces better results with some older drives.

Extraction Speed

Some CD-ROM drives deliver better audio quality when operated at lower extraction speeds.
NOTE: Not all drives support adjusting the speed!

Maximum speed setting: 4x

● For this track
○ For all tracks of this job
○ For all tracks

☐ No pause between audio tracks

Pause before this track 00:02:00

☐ Pre emphasis

☐ Copy protected

Figure 3. Win On CD 3.6 provides (among other features) jitter correction for reading in audio track data. Parameters such as the pre-emphasis bit and copy protection can be individually set for the CD to be recorded.

An enabled pre-emphasis bit is not automatically copied from the audio CD by most CD-recording programs. With Win On CD you can set it manually, which is a useful feature if you occasionally need it.

Copy protection
A number of copy-prohibit bits prevent an audio CD from being copied digitally more than once (that is, they prevent any further digital copying of a digital copy of a CD). The settings of these bits are also not necessarily copied intact by the recording software. Some programs allow copy protection to be manually enabled or disabled. If it is disabled, any number of secondary copies of the CD can be made (so that you can make a copy of the CD, and then a copy of the copy, and so on). This can be useful for recordings of your own material.

Analogue recordings

When you copy digitally recorded music you will seldom if ever need to do anything to the content, but if you make digital recordings from analogue sources, such as phonographs and cassette players, some editing of the music may well be useful or even essential. Who hasn't dreamed of being able to listen to some numbers from a rare LP (that has never been released on CD) without the usual noise? Digital technology provides quite a few possibilities in this regard.

What do you need to be able to make your own recordings?

First of all, of course, you need a computer with a CD burner. In most cases, the computer will be running Windows software.

In addition, you will naturally need a good-quality sound card. What does this mean? Almost all modern PCI sound cards provide good to outstanding sound quality, with a large dynamic range and little distortion. For recording material from phonograph records and cassettes, a sound card that costs on the order of £35 to £70 should thus be satisfactory. A cassette deck can be connected directly to the line inputs of the sound card, but a separate MD/MC phono preamplifier is needed for a phonograph (the specific type depends on the type of cartridge used). The best results are obtained when the preamplifier provides line-level outputs that can be directly connected to the line inputs of the sound card (since the microphone input of a sound card delivers inferior sound quality and is also only monophonic). Elsewhere in this issue you will find a design for a high-quality stand-alone MD/MC preamplifier, which is perfect for this application.

Finally, you naturally need software to read in the tracks from the records or cassettes and write the data to disk in wav format, following which the tracks can be cleaned up (if necessary) and used to 'burn' an audio CD.

Reading in audio signals
In principle, you can use the sound recorder function of Windows to read in analogue signals, but this is a rather primitive approach. It is better to use a program with more features, such as the well-known programs Cool Edit (*www.syntrillium.com*), Goldwave (*www.goldwave.com*) or Wavelab (*www.steinberg.net*). With these programs, you can more conveniently set parameters such as the sampling rate and the recording level. Many of these programs also have built-in VU meters, so that you can closely monitor the recording level. Be sure to carefully select the recording level. Overdriving is bad for the sound quality, but a signal recorded at too low a level contains too much noise. This is actually the same as for making recordings with a cassette recorder, but you should keep in mind that the audible effects of overdriving are much more evident in the digital domain than with analogue recordings.

It is important to select the correct input (line) in the Windows audio mixer before you start, and to set all other inputs to zero or switch them off. Pay particular attention to the microphone input, since it will add a lot of unnecessary noise if it is not disabled!

A program such as Cool Edit also allows the lead-in and trailer of a piece of music to be removed, so that the resulting wav file contains only exactly what is necessary.

Also make sure that everything is read in with a sampling rate of 44.1 kHz if you plan to record it on a CD that is to be played back using an ordinary audio CD player. Although good audio editing programs allow the data to be resampled (for example, to change the sampling rate of a digitized audio file from 48 kHz to 44.1 kHz), it is naturally better to avoid any unnecessary intermediate processing.

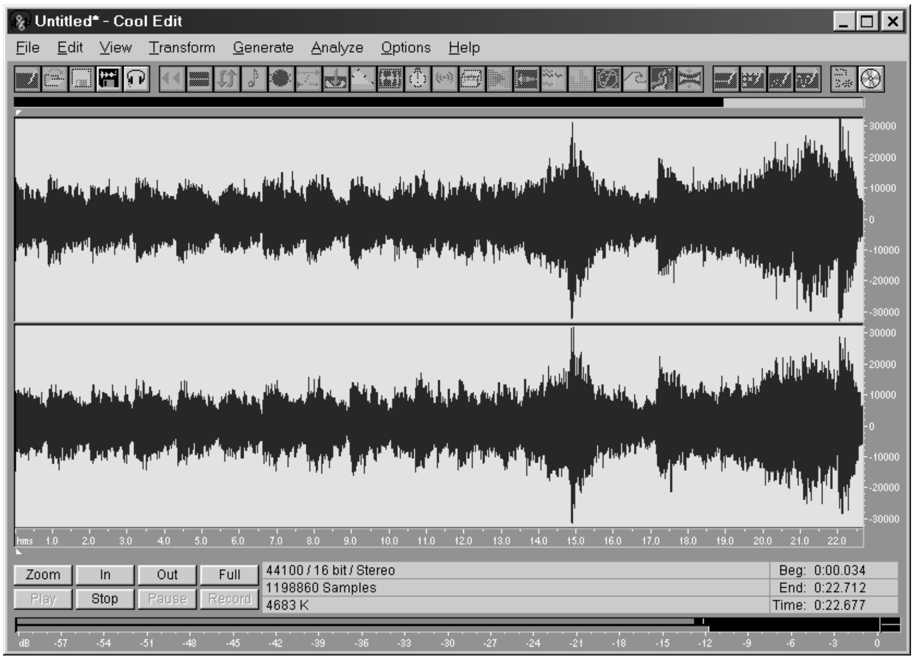
The indirect approach

As an alternative to digitizing the analogue signal using the sound card, you can first record the desired pieces of music using a DAT or MiniDisc recorder. This is often a more convenient and reliable approach, and the D/A converters in such recorders provide outstanding sound quality. After you have recorded the data, you can simply transfer the digital signal to the PC.

Of course, this approach makes other demands on the necessary hardware and software. First of all, you will need a card with a digital (S/PDIF) input in order to read the digital signals into the computer. This could for example be a Soundblaster Live card or a Terratec EWS64, or a special S/PDIF card such as the Digi32 from the German firm RME. Next, a translation step is often needed in the computer. A normal DAT recorder always works at a 48 kHz sampling rate. After the data that have been sampled at this rate have been read in, they must be resampled to 44.1 kHz with the help of a program such as Cool Edit. This problem is not present with a MiniDisc recorder, since it has an internal converter that always provides an output signal at 44.1 kHz. The disadvantage of using a MiniDisc recorder is that the data are compressed internally and possibly also resampled.

Editing

Various programs are available for editing wav files. For example, Sound Forge (*www.sfoundry.com*) and Steinberg Clean (*www.steinberg.net*) offer a lot of options. Nowadays, even CD recording programs such as Easy CD Creator de Luxe and Win On CD 3.6 include a number of editing modules that can for example remove noise and clicks. Although audio enthusiasts have been very sceptical about such editing in the past, it must be admitted that the capabilities of modern editing software are amazingly good. It is truly possible to very accurately locate and eliminate noise and crackles at the digital level, without affecting the audio signal.



44100 / 16 bit / Stereo
1198860 Samples
4683 K

Beg: 0:00.034
End: 0:22.712
Time: 0:22.677

Figure 4. A good-quality sound card is essential if you want make recordings from records or cassettes.

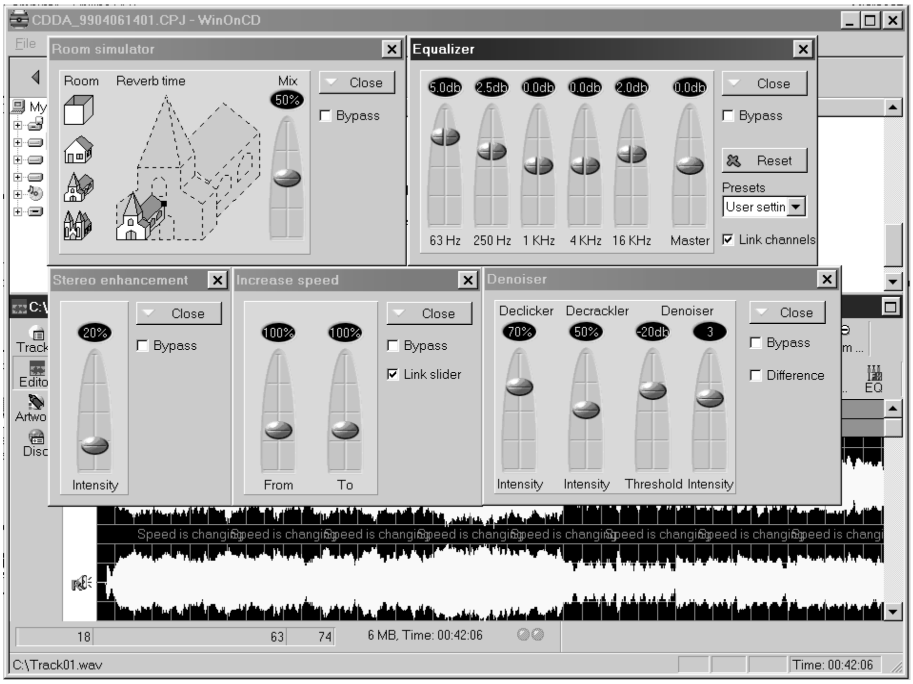
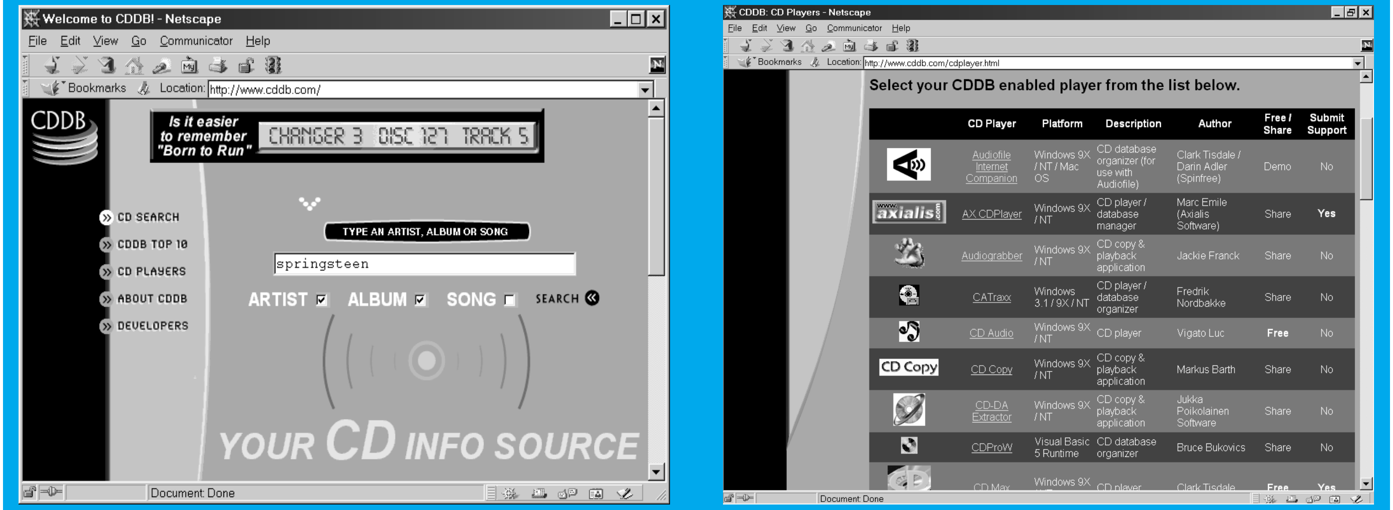


Figure 5. A program such as Cool Edit is very well suited to making recordings from phonograph records, and in addition it provides a large number of editing options, such as resampling.

CD databases

Making a complete list of the titles of all the tracks you have recorded on your CD, and putting the titles on a neat label or inlay for the CD case, can easily be a fairly time-consuming activity. Fortunately, there are also a number of interesting aids to help with this task. Everyone with access to the Internet can browse free of charge in the CDDB (CD Database), which is located at *www.cddb.com*. The track titles of several hundred thousand audio CDs are collected in this data base, and the number is increasing daily, since every user can make his or her own contributions to the data base. You can 'manually' look up the title of a CD in the CDDB and then copy the relevant information to your own program for further use, but there is also software available that makes automatic use of the CDDB. For example, there are programs for assembling your own CD database, CD players, CD jukeboxes and CD recording software that utilize the CDDB. Whenever the program or device needs the track information, it just makes a connection to the CDDB and downloads the necessary information.

In addition, there are programs available that have their own audio databases with track information. For example, the latest version of Win On CD (3.6 Power Edition) has its own database, with track titles from a number of well-known audio CDs. The exact number is not specified, but probably it will be possible to update this database as well via the Internet in the near future.


Welcome to CDDB! - Netscape
File Edit View Go Communicator Help
Bookmarks
Location: http://www.cddb.com/
CDDB
Is it easier to remember "Born to Run"
CHANGER 3 DISC 127 TRACK 5
CD SEARCH
CDDB TOP 10
CD PLAYERS
ABOUT CDDB
DEVELOPERS
TYPE AN ARTIST, ALBUM OR SONG
SEARCH
YOUR CD INFO SOURCE
Document: Done
CDDB: CD Players - Netscape
File Edit View Go Communicator Help
Bookmarks
Location: http://www.cddb.com/cdplayer.html
Document: Done

springsteen

ARTIST ☑ ALBUM ☑ SONG ☐

Select your CDDB enabled player from the list below.

CD Player	Platform	Description	Author	Free / Share	Submit Support
Audiofile Internet Companion	Windows 9X / NT / Mac OS	CD database organizer (for use with Audiofile)	Clark Tisdale / Darin Adler (Spinfree)	Demo	No
AX CDPlayer	Windows 9X / NT	CD player / database manager	Marc Emile (Axialis Software)	Share	Yes
Audiograbber	Windows 9X / NT	CD copy & playback application	Jackie Franck	Share	No
CATraxx	Windows 3.1 / 9X / NT	CD player / database organizer	Fredrik Nordbakke	Share	No
CD Audio	Windows 9X / NT	CD player	Vigato Luc	Free	No
CD Copy	Windows 9X / NT	CD copy & playback application	Markus Barth	Share	No
CD-DA Extractor	Windows 9X / NT	CD copy & playback application	Jukka Poikolainen Software	Share	No
CDProW	Visual Basic 5 Runtime	CD database organizer	Bruce Bukovics	Share	No
CD Max	Windows 9X	CD player	Clark Tisdale	Free	Yes

Figure 6. Win On CD includes various editing options, ranging from eliminating clicks to adding reverberation.

Exactly these sorts of defects plague LPs (especially older examples).

If we take Win On CD 3.6 again as an example, we see that there is a built-in audio editor that includes a 5-band graphic equalizer, a declicker for removing clicks, a decrackler for eliminating short ticks such as crackling or rattling sounds, and a 'denoiser' for removing broadband noise from a recording. There are also a number of optional 'effects', such as stereo enhancement, adjusting the playing speed and adding a certain amount of reverberation.

With Easy CD Creator de Luxe, a number of similar features are provided by the companion Spin Doctor program.

Burning the CD

After you have recorded and edited a number of wav files, you can put them all together onto a CD-R. Do not use a re-recordable CD (CD-RW), since the majority of audio CD players are absolutely unable to read such a CD.

With most CD burning programs, you can simply drag the various wav files from the 'explorer' window to the CD-R window in the order that you want to have them placed on the CD. To stay as compatible as possible with normal audio CD players, you should not put multiple sessions on an audio CD and you should select the 'disc at once' option, as previously mentioned. This guarantees that the resulting audio CD can be played back by all CD drives without any problems. Some programs allow you to specify the length of the pause between successive tracks, but usually this is fixed at 2 seconds.

A normal audio CD player will always recognize the various track numbers of a DIY CD. Sometimes you also have the option of placing index markers before burning the CD. This can be handy for classical music, which cannot be easily split into a number of short pieces. Index markers provide a simple method for jumping to the start of specific passages or movements.

The final touches

As you can see, it's not all that difficult if you just have the right kit: a computer with a sound card, a CD burner, a turntable with a separate preamplifier or a cassette recorder, and of course the necessary software. All that's then left is finishing off your product. If you have the time, you can make an attractive inlay and label for your self-made CD. There are currently a number of commercial packages available for generating CD labels (from HP and Traxdata, among others).

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Copyright

If you make your own music CDs, you must give due consideration to copyright aspects. It is perfectly OK to make a copy of music from your private collection of CDs and LPs for your own use, but you are not allowed to give or sell such copies to others who do not already own the original(s). After all, the artists have to live from something as well, and they suffer the most from illegal copying.